

**SYSTEM AND METHOD FOR TRANSLATING SYNCHRONIZATION  
INFORMATION BETWEEN TWO NETWORKS BASED ON DIFFERENT  
SYNCHRONIZATION PROTOCOLS**

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**Technical Field**

The present invention relates to mobile communications, and, more specifically, to systems for synchronizing data between mobile and conventional computing systems.

**Background of the Invention**

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With the growing use of mobile electronics devices, many systems are being developed to support replicating information contained on an information server, such as an e-mail server or the like, with those mobile devices. In response to a search command, some replication protocols provide that data that has changed state since the previous replication are identified by "change" and "delete" tags, as appropriate. If the data has been deleted since the previous replication, that data is identified with a "delete" tag. For data that has either been added or modified since the previous replication, that data is identified with a "change" tag.

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It is important to note that some replication protocols do not provide for an "add" event to indicate that a new object was added. One example of such a protocol is Exchange WebDAV-based replication. However, systems based on other synchronization protocols do support notifications for "add" events in addition to "change" and "delete" events. Such a system will not understand a message which indicates that a "change" should be made to an object that did not already exist. Thus, receiving such a command would result in undesirable behavior in a system that does not understand the "add" event. It would be advantageous to take advantage of "add" notifications even when replicating (also known as "synchronizing") with systems that do not provided add event notification, such as the DAV protocol.

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## Summary of the Invention

Briefly described, the present invention implements a mechanism to compute whether an event identified as a "change" event by a synchronization protocol that does not provide "add" event notification is actually an "add" event for the purpose of a protocol that implements an "add" event as different from a "change" event. For example, two systems may interact, one that communicates using a protocol that does not use "adds" (the "Server") and another that communicates using a protocol with "add" event support (the "client system"). On a first replication transaction between the two systems, a sync state table is created on an intermediate server or a server that facilitates communication between the information system and the client system. Although described in the context of a separate Server and intermediate server, it will be appreciated that a single computing system may be used to implement the same functionality

The sync state table is linked to the client system for future replication transactions. The sync state table maintains a list of objects that have been sent to the client system in past replication transactions. Thereafter, each time the client system performs a replication transaction with the Server, a manifest of changes since the last replication transaction is transmitted from the Server to the intermediate server. The manifest includes information about the changes or deletions, but without notice of "add" events. For each "change" event in the manifest, the object reported as changed is compared to the list of objects in the sync state table from the previous transaction. If the object does not exist in the table then the intermediate server changes the object's notification from a "change" tag to an "add" tag and the object is added to the sync state table. When the manifest has been fully processed, the sync state table is persisted for future use.

The present invention provides a system, which allows the maintenance of knowledge of objects, which reside on the client system. That information may then be used to determine whether an event identified as a "change" event is actually an "add" event. Advantageously, the intermediate server may translate the information from the manifest to a format that takes advantage of the additional add event notification capability.

### **Brief Description of the Drawings**

FIGURE 1 is a functional block diagram illustrating functional components of a conventional computing device that may be adapted to implement one embodiment of the present invention.

5           FIGURE 2 is a functional block diagram illustrating functional components of a mobile computing device that may be adapted to implement one embodiment of the present invention.

FIGURE 3 is a functional block diagram generally illustrating one system, implementing the present invention, for maintaining synchronization between a  
10       fixed data store and a mobile device.

FIGURE 4 is a functional block diagram generally illustrating the salient portions of a sample manifest used in conjunction with the present invention.

FIGURE 5 is a functional block diagram generally illustrating the salient portions of a sample sync state table used in conjunction with the present invention.

15           FIGURE 6 is a functional block diagram generally illustrating the salient portions of a sample new manifest created from the manifest illustrated in FIGURE 5 and the sync state table illustrated in FIGURE 5, in accordance with the present invention.

FIGURE 7 is a logical flow diagram generally illustrating a method for  
20       translating synchronization information between a mobile device and a server in accordance with the present invention.

### **Detailed Description of the Preferred Embodiment**

The present invention may be implemented in one or more components operating within a distributed or wireless computing network. Those components may  
25       include software programs or applications operating on computing systems of various configurations. Two general types of computing systems are being used to implement the embodiments of the invention described here. Those two general types are illustrated in FIGURE 1 and FIGURE 2 and described below, followed by a detailed discussion of one illustrative implementation of the invention, illustrated in  
30       FIGURES 3-6, based on these two types of computer systems.

### Illustrative Operating Environment

With reference to FIGURE 1, one exemplary system for implementing the invention includes a computing device, such as computing device 100. In a very basic configuration, computing device 100 typically includes at least one processing unit 102 and system memory 104. Depending on the exact configuration and type of computing device, system memory 104 may be volatile (such as RAM), non-volatile (such as ROM, flash memory, etc.) or some combination of the two. System memory 104 typically includes an operating system 105, one or more program modules 106, and may include program data 107. This basic configuration is illustrated in FIGURE 1 by those components within dashed line 108.

Computing device 100 may have additional features or functionality. For example, computing device 100 may also include additional data storage devices (removable and/or non-removable) such as, for example, magnetic disks, optical disks, or tape. Such additional storage is illustrated in FIGURE 1 by removable storage 109 and non-removable storage 110. Computer storage media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data. System memory 104, removable storage 109 and non-removable storage 110 are all examples of computer storage media. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by computing device 100. Any such computer storage media may be part of device 100. Computing device 100 may also have input device(s) 112 such as keyboard, mouse, pen, voice input device, touch input device, etc. Output device(s) 114 such as a display, speakers, printer, etc. may also be included. These devices are well known in the art and need not be discussed at length here.

Computing device 100 may also contain communication connections 116 that allow the device to communicate with other computing devices 118, such as over a network. Communications connections 116 is one example of communication media.

Communication media may typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and includes any information delivery media. The term “modulated data signal” means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. The term computer readable media as used herein includes both storage media and communication media.

#### 10 Mobile Computing Device

FIGURE 2 is a functional block diagram illustrating functional components of a mobile computing device 200. The mobile computing device 200 has a processor 260, a memory 262, a display 228, and a keypad 232. The memory 262 generally includes both volatile memory (e.g., RAM) and non-volatile memory (e.g., ROM, Flash Memory, or the like). The mobile computing device 200 includes an operating system 264, such as the Windows CE operating system from Microsoft Corporation or other operating system, which is resident in the memory 262 and executes on the processor 260. The keypad 232 may be a push button numeric dialing pad (such as on a typical telephone), a multi-key keyboard (such as a conventional keyboard). The display 228 may be a liquid crystal display, or any other type of display commonly used in mobile computing devices. The display 228 may be touch sensitive, and would then also act as an input device.

One or more application programs 266 are loaded into memory 262 and run on the operating system 264. Examples of application programs include phone dialer programs, email programs, scheduling programs, PIM (personal information management) programs, word processing programs, spreadsheet programs, Internet browser programs, and so forth. The mobile computing device 200 also includes non-volatile storage 268 within the memory 262. The non-volatile storage 268 may be used to store persistent information which should not be lost if the mobile computing device 200 is powered down. The applications 266 may use and store information in the storage 268, such as e-mail or other messages used by an e-mail application, contact

information used by a PIM, appointment information used by a scheduling program, documents used by a word processing application, and the like. A synchronization application also resides on the mobile device and is programmed to interact with a corresponding synchronization application resident on a host computer to keep the information stored in the storage **268** synchronized with corresponding information stored at the host computer.

The mobile computing device **200** has a power supply **270**, which may be implemented as one or more batteries. The power supply **270** might further include an external power source, such as an AC adapter or a powered docking cradle, that supplements or recharges the batteries.

The mobile computing device **200** is also shown with two types of external notification mechanisms: an LED **240** and an audio interface **274**. These devices may be directly coupled to the power supply **270** so that when activated, they remain on for a duration dictated by the notification mechanism even though the processor **260** and other components might shut down to conserve battery power. The LED **240** may be programmed to remain on indefinitely until the user takes action to indicate the powered-on status of the device. The audio interface **274** is used to provide audible signals to and receive audible signals from the user. For example, the audio interface **274** may be coupled to a speaker for providing audible output and to a microphone for receiving audible input, such as to facilitate a telephone conversation.

The mobile computing device **200** also includes a radio interface layer **272** that performs the function of transmitting and receiving radio frequency communications. The radio interface layer **272** facilitates wireless connectivity between the mobile computing device **200** and the outside world, via a communications carrier or service provider. Transmissions to and from the radio interface layer **272** are conducted under control of the operating system **264**. In other words, communications received by the radio interface layer **272** may be disseminated to application programs **266** via the operating system **264**, and vice versa.

#### Illustrative Synchronization System

FIGURE 3 is a functional block diagram generally illustrating one system, implementing the present invention, for maintaining synchronization between a

fixed data store, such as an information server **310**, and a mobile device **320**. In this implementation, the information server **310** is a computing device such as the one described above in conjunction with FIGURE 1, and the mobile device is a mobile computing device such as the one described above in conjunction with FIGURE 2.

5           The information server **310** includes a data store **311** on which resides information that is used by a user of the mobile device **320**. For example, the information server **310** could be an e-mail server that houses e-mail messages, contact information, appointment information, and the like for the user. Another copy of the information also resides on the mobile device **320** within a mobile data store **321**. The  
10   set of similar information that resides in a specific folder on both the information server **310** and the mobile device **320** is referred to as a "collection." By storing the collection on both the information server **310** and the mobile device **320**, the user always has access to the collection, such as via a conventional computing system connected to the information server **310** or directly through the mobile device **320**.  
15   However, to ensure that changes to the collection that occur on the mobile device **320** are reflected in the information server **310** and vice versa, the two computing systems are synchronized.

          Synchronization between the two devices may be performed via a synchronization server **330** that is in communication with both the information  
20   server **310** and the mobile device **320**. It will be appreciated that the synchronization server **330** may be collocated with the information server **310**, such as within a corporation or other business enterprises. Alternatively, the synchronization server **330** may be part of a mobile communications service provider that is in wireless communication with the mobile device **320** and in communication with the information  
25   server **310**. In still another alternative, the synchronization server **330** may be part of the mobile device itself.

          The synchronization server **330** is coupled to the information server **310** over a local or wide area network in the conventional manner. The information server **310** provides synchronization (or replication) capability using a protocol that  
30   does not make use of "add" event notification, such as the Document Authoring and Versioning (DAV) standard protocol (sometimes referred to as WebDAV). Although

reference is made to the use of the DAV or WebDAV protocol, that is only one example of a protocol that does not include "add" event notification, and the present invention is equally applicable to any similar protocol.

In accordance with that protocol, other applications may interact with the data store 311 to view, modify, and retrieve items within the collection. As is well known in the art, a synchronization operation basically occurs as follows. A client, such as the synchronization server 330, issues to the information server 310 a sync command (e.g., a PROPFIND or SEARCH command). The sync command includes a notification of the items within the collection that the client already has and their state so that the information server 310 does not retransmit the same information.

The information server 310 responds to the sync command by identifying any items in the collection on the data store 311 that the client does not already have the current version of together with additional information about how that information is different (i.e., how the information should be modified to reflect the current version). The client then uploads to the information server 310 any items that the client knows has changed since the last synchronization, and downloads any new items from the data store 311.

More specifically, the information server 310 responds to the sync command by returning a "manifest" 312 that includes a list of changes in the collection on the data store 311. The manifest 312 may also include information identifying the changes to make to the collection on the mobile device 320 to synchronize the information. One example of the structure of a manifest is illustrated in FIGURE 4 and described below. One important feature of the manifest 312 is that, in accordance with the particular protocol being used between the information server 310 and the synchronization server 330, only "change" and "delete" related instructions are provided. In other words, if an item has been added to the collection on the information server 310, a "change" instruction would be included in the manifest 312 identifying the new item.

In contrast, the synchronization protocol used between the mobile device 320 and the synchronization server 330 makes use of an "add" instruction, and if issued a "change" instruction for an item, which does not yet exist on the mobile device 320,



the synchronization transaction may fail, at least for the specific item. For this reason, the synchronization server **330** of this implementation employs mechanisms for determining when a "change" instruction is in fact an "add" instruction, and for replacing those "change" instructions with the appropriate "add" instructions.

5           The synchronization server **330** maintains, among other things, a sync state table **331**. Information about the current version of the items in the collection on the mobile device **320** is stored in the sync state table **331**. The stored information may be as simple as only a unique identifier for each item in the collection on the mobile device **320** (e.g., a replication unique identifier or "Repl-UID"). The sync state table  
10       **331** is associated with the mobile device such that each synchronization transaction causes the synchronization server **330** to update the sync state table **331**.

          The sync state table **331** identifies which items already exist in the collection on the mobile device **320**. Thus, when the manifest **312** comes in, the information in the manifest **312** is compared to the sync state table **331** to identify any  
15       items which are marked "change" in the manifest **312** but which do not yet exist on the mobile device **320**. Put another way, the synchronization manager **330** determines whether any items marked with a "change" instruction in the manifest **312** are identified in the sync state table **331**. If not, then the instruction marked as "change" in the manifest is in actuality an instruction to add the item. Thus, the synchronization  
20       server **330** can change those instructions to the proper "add" instruction, and create a new manifest **322**. The new manifest **322** includes the substantive information from the manifest **312**, except that "change" instructions that are actually "adds" are replace with the appropriate instructions. The new manifest **322** is then transmitted to the mobile device **320** to continue the synchronization transaction.

25           FIGURE 4 is a functional block diagram generally illustrating the salient portions of a sample manifest **312** used in conjunction with the present invention. In the sample manifest **312**, each row is associated with a particular item or message, such as a single e-mail message or contact. Each entry includes three columns of information: an action column **401**, an ID column **403**, and an object data column **405**. The ID  
30       column **403** identifies the particular item to which the record in the manifest **312** pertains. For example, an item in the collection could be an e-mail message identified

by the Repl-UID "XXXX123." The action column **401** identifies the particular action to perform on the property. The object data column **405** includes the particular properties of the corresponding item.

FIGURE 5 is a functional block diagram generally illustrating the salient portions of a sample sync state table **331** used in conjunction with the present invention. It includes at least one column, an ID column **503**, that contains unique identifiers associated with each item in the collection stored on the mobile device **320**. The sync state table **331** may be created by the synchronization server **330** during a first synchronization transaction of the mobile device **320**, or, alternatively, may be provided by the mobile device **320** to the synchronization server **330** at any other time.

FIGURE 6 is a functional block diagram generally illustrating the salient portions of a sample new manifest **322** used in conjunction with the present invention. The new manifest **322** closely resembles the manifest **312** and includes the same columns, action column **601**, ID column **603**, and object data column **605**. However, because the new manifest **322** is compatible with a different type of synchronization protocol, it may include "add" instructions **611** in the action column **601**, unlike the manifest **312**.

It should be noted that although the conceptual image of the new manifest **322** closely resembles the conceptual image of the manifest **312**, those skilled in the art will appreciate that the programmatic differences may be extensive. For instance, one manifest may be in an eXtensible Markup Language (XML) format having a first schema, and the new manifest may be in an XML format having a completely different schema, although the information contained is similar.

#### Illustrative Synchronization Method

FIGURE 7 is a logical flow diagram generally illustrating a method **700** for translating synchronization information between a mobile device and a server in accordance with the present invention. The method **700** begins with the initiation of a synchronization transaction. At decision block **701**, the method determines whether the current synchronization transaction (also called a "replication") is the first synchronization of the mobile device **320** with the information server **310**.

If the current synchronization transaction is the first one, at block **703**, the synchronization server **330** creates a new, empty sync state table, such as the one described above in conjunction with FIGURE 5 and links the new sync state table with the mobile device **320**. The synchronization server **330** may initially populate the sync state table with any objects identified by the mobile device **320** during the current synchronization transaction. If the current synchronization transaction is not the first, at block **705**, the synchronization server loads a previously-stored sync state table associated with the collection on the mobile device **320**. The sync state table maintains a list of objects that have been sent to the mobile device **320** in past synchronization transactions.

With the sync state table loaded or created, at block **707**, the synchronization server **330** performs a replication search to create a manifest of change and delete events. As described above, the sync server **330** issues a sync command to the information server **310**, which returns the manifest identifying each item that has changed since the last replication.

At block **709**, the method **700** enters an iterative loop **710** including decision block **711**, decision block **713**, and block **715**. The loop **710** is repeated for each item in the manifest received at block **707**. The loop **710** determines whether each item is identified as a "change" (at decision block **711**), and if not, proceeds to the next item in the manifest. However, for each "change" item in the manifest, a determination is made (at decision block **713**) whether the item marked as "change" exists within the sync state table. If so, then the loop proceeds to the next item in the manifest. But if the item marked as "change" does not exist in the sync state table, then its action type is changed from "change" to "add" (at block **715**) and the item is added to the sync state table. At decision block **717**, a determination is made whether there are more items to process, and if so, the loop continues. Otherwise, the process ends. After all entries in the manifest have been processed, the sync state table is persisted for use in the future.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.